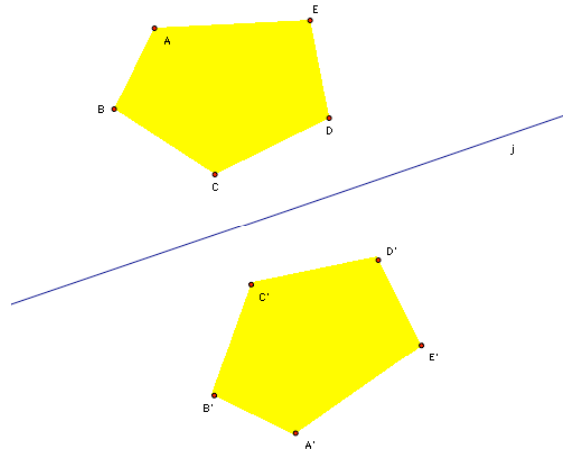


How to build a Kaleidoscope in Sketchpad

Before beginning the kaleidoscope, students should know about *reflections*. A *reflection* is obtained by first constructing a line and some geometric shape, then designating the line to be a *mirror*, across which the shape is “flipped.” A basic example of a reflection is shown below:

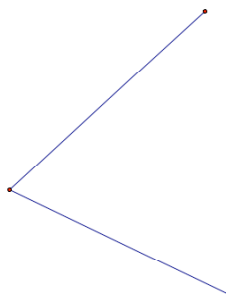


Pentagon $A'B'C'D'E'$ is the reflection of pentagon $ABCDE$ across line j . Although a very simple idea, multiple reflections will become the basic structure of our kaleidoscope.

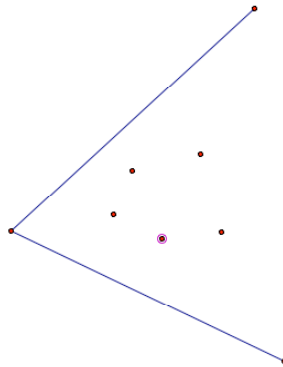
To help us to create these multiple reflections, we are going to create a custom tool in Sketchpad. This tool will save a lot of work, as all custom tools do.

STEPS:

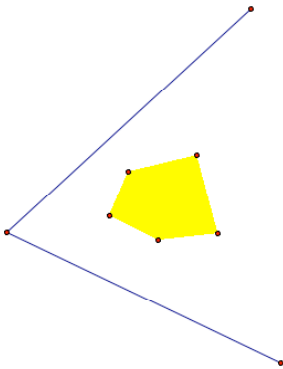
1. Open Sketchpad
2. Enlarge your window as much as possible for best viewing.
3. Using the **segment tool**, construct an angle measuring approximately 45° at the center of your sketch.



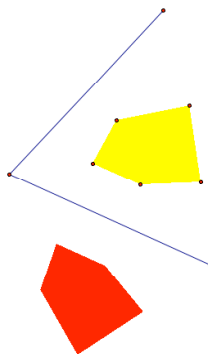
4. In the interior of this angle, use the **point tool** to construct 5 points, in the shape of a pentagon (results may vary).



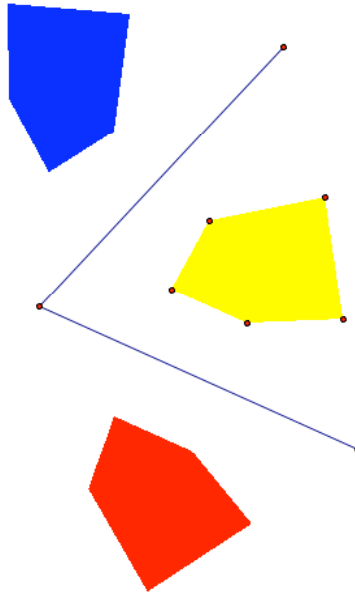
5. Click on the **selection tool**, select the 5 points (clockwise or counterclockwise, starting at any point), then click on **CONSTRUCT-PENTAGON INTERIOR**. Click anywhere in the white space.



6. Select the lower side of the angle, and click **TRANSFORM-MARK MIRROR**. The segment should flash at you. Now select the pentagon, and click **TRANSFORM-REFLECT**. A new pentagon should appear below the segment, the “mirror image” of the first. This new pentagon will have a grid in it; click **DISPLAY-COLOR** and choose a color for this new pentagon. Click anywhere in the white space.



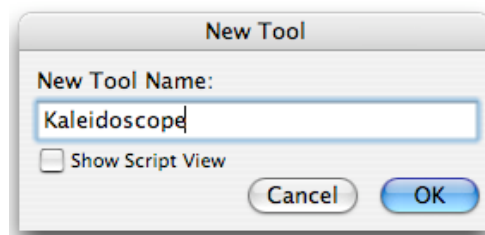
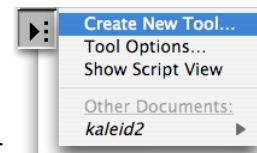
7. Now we have to repeat that for the upper segment. Select the segment, click **TRANSFORM-MARK MIRROR**. The segment should flash at you. Now select the pentagon, and click **TRANSFORM-REFLECT**. A new pentagon should appear above the segment, again, the “mirror image” of the first. Change its color as you did before. Click anywhere in the white space.



We now have our basic construction, a dual reflection which we want to mechanize and repeat many times.

7. Select, in the following order,
 - a. The initial pentagon in the interior of the angle
 - b. The lower side of the angle
 - c. The upper side of the angle
 - d. The lower pentagon (under the lower side)
 - e. The upper pentagon (above the upper side)

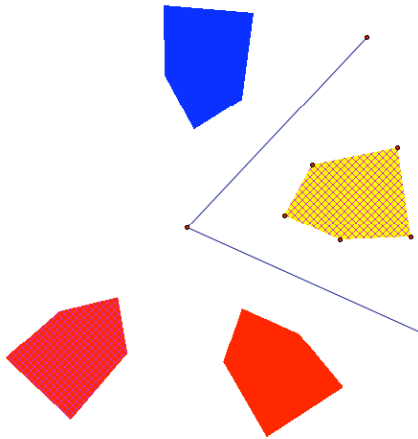
8. Click and drag the tool button -  - you will see this menu: move the mouse to highlight **Create New Tool...** and release. Enter a name for your sketch (Kaleidoscope?) in the dialog box and click OK.



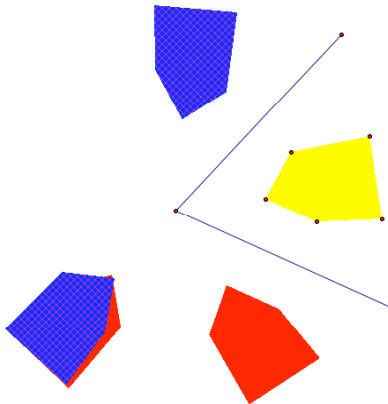
9. Now we want to create many new pentagons. We will use this Kaleidoscope tool



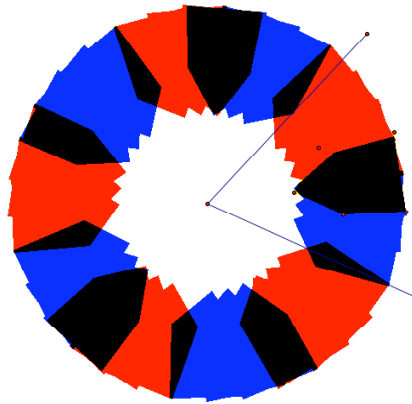
to accomplish this. Click and drag the button, and make sure “Kaleidoscope” has a check box next to it. Put your mouse on the blue pentagon; it will show a red border. Click the pentagon, then the lower side of the angle, then the upper side. You will see this:



The red pentagon with a grid is the reflection of the blue one across the lower side; the yellow pentagon with the grid is the blue one's reflection across the upper side. It is true that we already had the yellow one – all we really get is one new pentagon. Click anywhere in the white space. Click the new red pentagon, then the lower side, then the upper side.

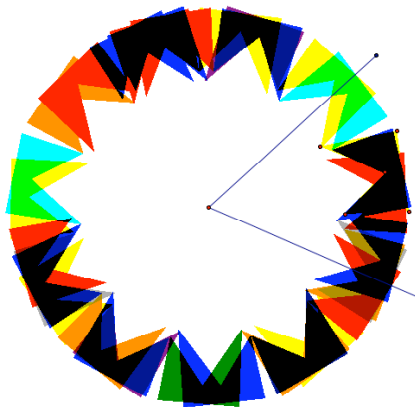


Now you have a new blue pentagon! The other we already had. Click anywhere in the white space. Now select the new blue one (careful to get the right one!) and select the lower and upper sides. Click in the white space. Now click the newest pentagon, lower, upper, and so on. Repeat this about 10 times, and you should get this:

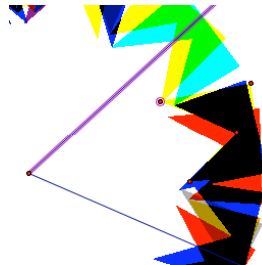


Now would be good time to add some colors. Click the select tool, and click 3 pentagons around the shape – then go to **DISPLAY-COLOR** and choose a color. Repeat this as many times as you like.

10. Can you see the original 5 points we used for the first pentagon? Click and drag any one of those, and see how it changes the shape of all the others! If you drag the point most towards the center, you will get a better kaleidoscope effect.

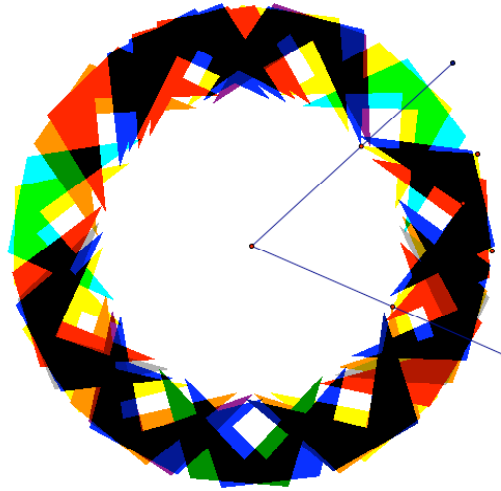


11. I'm going to click one of the points that make up the pentagon, then the upper side – so this is what it looks like:

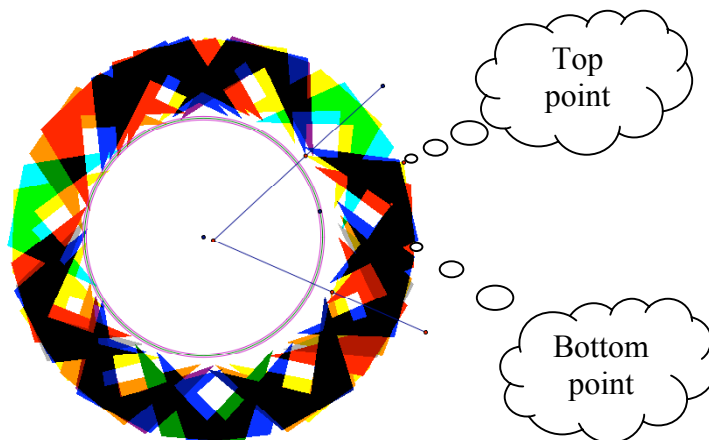


Now, click **EDIT-MERGE POINT TO SEGMENT**. What this does it change for shape, and also prepare for animation. You can choose any one of the 5 points, but it seems that I

get the best results when it's the "top-inside" point. I will repeat the above step with the lower inside point and the lower side:

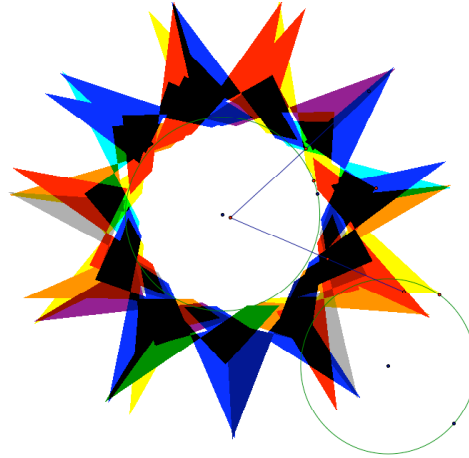


12. Now for the real animation controllers. Click the circle tool, and draw a circle with its center at the center of the sketch. **Be sure that the circle does not contact any of the existing points!**



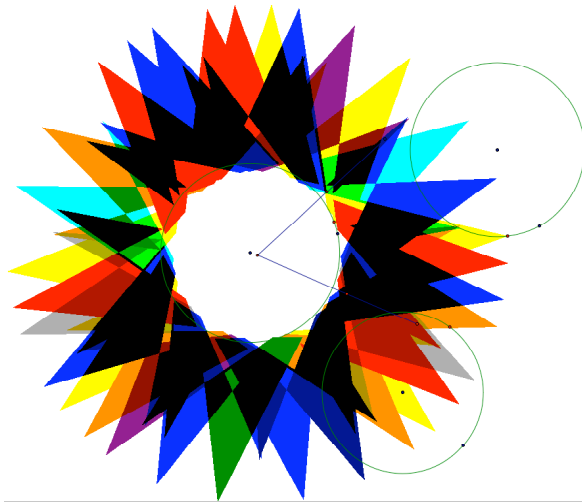
Now select the top point and the circle, and then choose **EDIT-MERGE POINT TO CIRCLE**.

13. Construct another circle as in the figure below, and merge the bottom point of the original pentagon to it.



How do I know where to put these circles? Just through experimentation. It's OK to put yours anywhere – all different kinds of results will occur!

14. Construct one more circle, and merge the last remaining point to it.



15. Almost done! Click on **one** of the colors, then **DISPLAY-ANIMATE PENTAGON**. Click anywhere in the white space. You can use the controller to speed up, slow down, reverse, etc. the effects you see. *Voilà!!!!* You could also select and “hide” the points, circles, and segments.